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EXHAUST GAS FILTER AND FILTERING SYSTEM

FIELD OF INVENTION

[00001] The present invention relates to an exhaust gas filter and filtering system, such as a filter cartridge alone and in combination with a filtering system such as a muffler. More particularly, the present invention relates to an internal combustion engine exhaust gas filter and filtering system comprising an elongated filter cartridge and an absorbent material operatively located inside of the filter cartridge. The absorbent material preferably absorbs liquids and gaseous fumes. A preferred absorbent material is diatomite pellets.

BACKGROUND OF THE INVENTION

[00002] Numerous attempts have been made to produce satisfactory filtering devices for removing objectionable constituents from the exhaust gases of internal combustion engines. The filters of the prior art have been subject to two common mechanical faults, namely, channeling of the gases in the filter element whereby intimate contact between the gases to be filtered and the filter element is not achieved and a deterioration of the structure of the exhaust

gas filter element due to the corrosive effects of the exhaust gases at the high temperatures involved.

[00003] The prior art discloses various filtering devices. Known in the prior art is Adiletta, U.S. Patent No. 5,470,364, which discloses a diesel exhaust filter including a microporous filter for removing particulate contaminants. The filter material can be made of fibers or powders, such as high purity silica, aluminosilicate or boronsilicate-E glass.

[00004] Also known in the prior art is von Blücher et al., U.S. Patent No. 4,906,263, which discloses an adsorption filter for removing undesirable gases or fluids. The filter includes a fixed bed of adsorber particles which are pourable and abrasion-resistant. The adsorber particles can be beads having a diameter of 0.1-1 mm. Diatomite is disclosed as being suitable for use.

[00005] Also known is Shiba et al., U.S. Patent No. 6,423,534 B1, which discloses a method and apparatus for decomposing and eliminating ethanol in exhaust gas. The apparatus includes a filter material including a microorganism. The filter material for carrying the microorganism can be of diatomaceous earth.

[00006] Also known is Colvin et al., U.S. Patent No. 3,933,643, which discloses electrically conductive filter elements including a carbonaceous conductive material and optionally other fibrous material, such as silica, or a bed-type filter, such as a diatomaceous earth.

[00007] Also known is Iida et al., U.S. Patent No. 4,728,503, which discloses a filter medium for treating an exhaust gas including a porous ceramic substrate with a pre-coat layer to prevent clogging of the porous substrate, and a layer of slaked lime or calcium carbonate and calcium chloride. The pre-coat layer can be of a powder of diatomaceous earth.

[00008] Also known is Dufour, U.S. Patent No. 5,179,062, which discloses a method of producing filtration agents. The method involves the calcination of diatomites in a circulated bed furnace to control agglomeration of the diatomaceous particles.

[00009] Also known in the prior art relating to exhaust mufflers, including with perforated tubes and a particulate trap, are Jacobs et al., U.S. Patent No. 3,960,528; Hoggatt, U.S. Patent No. 4,318,720; Schuster et al., U.S. Patent No. 5,223,009; and Herman et al., U.S. Patent No. 5,246,472.

None of these patents disclose diatomites utilized with the muffler.

[00010] The present invention achieves a remedy to the prior art deficiencies noted above, and not addressed in the prior art, by a novel filter device and filtering system, and in particular a novel filter cartridge.

SUMMARY OF THE INVENTION

[00011] The present invention relates to an exhaust gas filter and filtering system, such as a filter cartridge alone and in combination with a filtering system such as a muffler. More particularly, the present invention relates to an internal combustion engine exhaust gas filter comprising an elongated filter cartridge, which is preferably a disposable cartridge, and an absorbent material operatively located inside of the filter cartridge. The absorbent material preferably absorbs liquids and gaseous fumes. The absorbent material is a diatomite material, preferably in pellet form.

[00012] A guard casing, e.g. muffler housing, can be present in combination with the filter cartridge to form the filtering system. The guard casing preferably has end closure structures and longitudinal internal surfaces. An

exhaust gas inlet end structure is preferably associated with one end closure structure and a treated gas outlet end structure is preferably associated with the other end closure structure. The elongated filter cartridge may be preferably designed for reception within the guard casing.

[00013] The filter cartridge has porous longitudinal surfaces and may have a porous external end surface or a non-porous external end surface. Specifically, the filter cartridge comprises an internal tube and an external tube, both tubes having openings of suitable size to allow for an adequate gas flow through the tubes to provide for treatment during movement of an exhaust gas flow through the cartridge. The openings are preferably louvers or mesh openings which allow for a greater gas flow through the internal and external tubes of the filter cartridge. As such, the filter cartridge is gas permeable from end to end, radially from the longitudinal external surface thereof and radially from the longitudinal internal surface thereof. A gaseous and odor absorbent diatomite material is housed substantially in-between the concentric layers of the filter cartridge, i.e., in-between the internal tube and external tube of the filter cartridge.

[00014] The filter cartridge may also comprise a mesh tube outside and around the external tube. The mesh tube aids in controlling the exhaust gas flowing through the filter cartridge.

[00015] The filtering system of the present invention may comprise a spacing means such as, but not limited to, at least one bracket or at least one holder plate. The spacing means, i.e., bracket or holder plate, may be formed of rigid sheet material, preferably refractory relative to the temperature and corrosive characteristics of the exhaust gases. The spacing means may preferably be disposed in contiguous relation to the longitudinal internal surface of the guard casing for holding the filter cartridge within the guard casing with the porous longitudinal external surface of the filter cartridge being in contact with the spacing means.

BRIEF DESCRIPTION OF THE DRAWINGS

[00016] Referring now to the drawings:

[00017] FIGURE 1 is a top cross-sectional view of a gas filter of the present invention in combination with a muffler structure;

[00018] FIGURE 2 is a longitudinal cross-sectional view of a first embodiment of the gas filter of the present invention in combination with a muffler structure;

[00019] FIGURE 3 is a cross-sectional view taken along line 3-3 of FIGURE 2;

[00020] FIGURE 4 is a cross-sectional view taken along the line 4-4 of FIGURE 2;

[00021] FIGURE 5 is a cross-sectional view of a second embodiment of the gas filter of the present invention in combination with a muffler structure;

[00022] FIGURE 6 is a cross-sectional view of a third embodiment of the gas filter of the present invention in combination with a muffler structure;

[00023] FIGURE 7 is a schematic view of the filter of the present invention in an environment of use, e.g. attached to a tailpipe of an exhaust gas system; and

[00024] FIGURE 8 is a perspective view of a fourth embodiment of the gas filter of the present invention in combination with a muffler structure.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[00025] The present invention relates to a gas filter, preferably in the form of a disposable cartridge for use

alone and in combination with an exhaust gas filtering system such as an internal combustion engine exhaust gas system. Referring to FIGURES 1-8, an exhaust gas filtering system 10 of the present invention comprises (1) an elongated guard casing 12, which is preferably cylindrical, has end closure structures and longitudinal internal surfaces, (2) an elongated filter cartridge 24 according to the invention, which is preferably replaceable and (3) an absorbent material operatively located inside the filter cartridge 24. A gas inlet end structure 14 is preferably associated with one end closure structure and a gas outlet end structure 16 is preferably associated with the other end closure structure of the guard casing 12.

[00026] Since internal combustion engine exhaust gas filters often operate at temperatures as high as 500°F and higher and include constituents which are extremely corrosive at elevated temperatures, the guard casing 12 and the filter cartridge 24 may be formed from a material such as, but not limited to, stainless steel, aluminum-coated steel, lead-coated steel, aluminum, a polymer-fiberglass material or any combination thereof. A filtering system 10 made from aluminum or polymer-fiberglass is lightweight, strong and heat resistant.

[00027] The filter cartridge 24 of the present invention is preferably elongated, replaceable and structured for reception in the guard casing 12 operatively near the gas inlet end structure 14. The filter cartridge 24 has porous longitudinal surfaces and may or may not have porous end surfaces. Specifically, the filter cartridge 24 preferably has two ends, an internal tube 26 and an external tube 28. A gaseous and odor absorbent material is housed substantially in-between the concentric layers of the filter cartridge 24, i.e., in-between the internal tube 26 and the external tube 28 of the filter cartridge 24. In the preferred embodiment, the absorbent material 40 is a diatomite material, which is further described hereinafter.

[00028] The internal tube 26 and the external tube 28 include openings 31 of a suitable size to allow for adequate gas flow. The openings 31 are preferably louvers or mesh openings which allow for a greater gas flow through the internal tube 26 and the external tube 28 of the filter cartridge 24. As such, the filter cartridge 24 is gas permeable along its length, radially from the longitudinal external surface thereof and radially from the longitudinal internal surface thereof. Additionally, a core air passage 34 is formed inside of the internal tube 26 through which

exhaust gas moves when the filter cartridge 24 is used alone or in conjunction with a filtering system such as a muffler.

[00029] The filter cartridge 24 of the present invention is preferably of cylindrical shape. However, the filter cartridge 24 may be of any suitable shape. In addition, the internal tube 26 and the external tube 28 of the filter cartridge 24 may be formed from any suitable material. In a preferred embodiment, the tubes 26 and 28 are preferably formed from stainless steel, aluminum-coated steel, lead-coated steel, aluminum, a polymer-fiberglass material or any combination thereof.

[00030] A polymer-fiberglass material is a preferable material from which to form the tubes 26, 28 of the filter cartridge 24 since this material is lightweight, strong and heat resistant. Specifically, a polymer-fiberglass filter cartridge can withstand temperatures up to 1300°F. As such, the polymer-fiberglass material can easily withstand typical heat exhaust which is generally in a temperature range from about 150-200°F. However, stainless steel is also a preferable material from which to form the tubes 26, 28 of the filter cartridge 24 since this material is also strong and heat resistant.

[00031] In a preferred embodiment as shown in FIGURE 2, the openings 31 in internal tube 26 and external tube 28 of the filter cartridge 24 are louvers of a sufficient size to provide for desired permeation and exhaust gas flow. The louvers preferably range in size from about one-eighth of an inch (1/8 inch) to about three-eighths of an inch (3/8 inch), and most preferably from about one-quarter of an inch (1/4 inch) to about five-sixteenths of an inch (5/16 inch).

[00032] In another preferred embodiment as shown in FIGURE 6, internal tube 26 and external tube 28 are formed from a mesh material such that the openings 31 in internal tube 26 and external tube 28 of the filter cartridge 24 are mesh openings. The mesh openings are of a sufficient size to provide for desired permeation and exhaust gas flow. The mesh openings preferably range in size from about one-eighth of an inch (1/8 inch) to about three-eighths of an inch (3/8 inch), and most preferably from about one-quarter of an inch (1/4 inch) to about five-sixteenths of an inch (5/16 inch). The material used to form the mesh openings of internal tube 26 and external tube 28 of the filter cartridge 24 is preferably a stainless steel material ranging in thickness from about 12 gauge to about 16 gauge. However, any suitable material of any suitable thickness may be used.

[00033] The gaseous and odor absorbent material housed in-between the internal tube 26 and external tube 28 of the filter cartridge 24 is a diatomite material. Diatomite is a sedimentary rock primarily composed of fossilized remains of unicellular fresh water plants known as Diatoms. Diatomite is approximately 90% silicon dioxide, with the remainder of its contents being elemental minerals. Diatomite 40 of the present invention absorbs odors, fumes, liquids and undesired gases from the exhaust gas entering the filter cartridge 24 and the filtering system 10, such as from gasolines and diesel gas, so that the exiting gas is essentially free of these odors, fumes, liquids and undesired gases which can pollute the environment. The diatomite 40 of the present invention is also strong enough to destroy smog which passes through the filter cartridge 24 from an engine.

[00034] The diatomite material of the present invention is preferably in the form of pellets. The diatomite pellets 40 may be any suitable size of pellets. However, the diatomite pellets 40 preferably range in size from about one-quarter of an inch (1/4 inch) to about five-eighths of an inch (5/8 inch). Specifically, diatomite pellets of the size such as MP 94 and MP 95 are preferred and are in a size

range of one-half of an inch (1/2 inch) to five-eighths of an inch (5/8 inch). The size of the diatomite pellets 40 preferably has correspondence to the size and the power of the engine used in conjunction with the filter cartridge 24 of the present invention. For example, 4-cylinder, V6 and V8 engines are utilized with a cartridge including pellets in a size range of 1/4 inch to 1/2 inch, 1/4 inch to 1/2 inch, and 1/4 inch to 5/8 inch, respectively.

[00035] Diatomite pellets 40 are an advantageous absorbent material for use in a filter cartridge 24 in combination with an exhaust gas filtering system 10 of the present invention because the diatomite is lightweight and safe to use since it is not harmful to humans, animals, plants or bodies of water. Additionally, the diatomite pellets 40 have no reaction at temperatures tested over 5000°F. As such, these diatomite pellets 40 are fire resistant and aid in preventing tubes 26 and 28 of the filter cartridge 24 from overheating or rusting due to the flow of the exhaust through the filter cartridge 24. Additionally, the life of the diatomite pellets 40 of the present invention is preferably from about 60,000 miles to about 100,000 miles depending on the maintenance and driving conditions of the engine.

[00036] In order for the diatomite pellets 40 to provide the desired absorption of undesired gases from the engine exhaust, the gas flow pressure through the filter cartridge 24 is preferably less than five pounds per square inch (5 psi). In a preferred embodiment, the gas flow pressure through the filter cartridge 24 of the present invention is 1.5 psi, well within the preferred range. The gas flow pressure through the filter cartridge 24 is important to maintain a strong gas flow through the diatomite so that forceful contact is obtained to assist in absorption of contaminants from the gas flow by the diatomite.

[00037] In a further preferred embodiment, the filter cartridge 24 may extend the entire length of guard casing 12 from the gas inlet end structure 14 to the gas outlet end structure 16, as shown in FIGURE 5. However, in another preferred embodiment, the filter cartridge 24 may extend only part of the length of the guard casing 12, such that the filter cartridge 24 extends from the gas inlet end structure 14, through the guard casing 12, but stops short of reaching the gas outlet end structure 16, as shown in FIGURES 1, 2, 6 and 8.

[00038] Where the filter cartridge 24 does not extend the entire length of the guard casing 12 to the gas outlet end structure 16, as shown in FIGURES 1, 2, 6 and 8, a stopper plate 30 may be secured to the end of the filter cartridge 24 which is opposite the gas inlet end structure 14 of the guard casing 12. The stopper plate 30 prevents exhaust gas from escaping through the end of the filter cartridge 24 without passing through the diatomite pellets 40. The stopper plate 30 is preferably made of a heavy-duty heat-proof material such as stainless steel, aluminum-coated steel, lead-coated steel, aluminum, polymer-fiberglass or any combination thereof.

[00039] The stopper plate 30 may be completely solid or may have a plurality of openings 31 near its outer circumference located adjacent the diatomite pellets 40 in-between external tube 28 and internal tube 26 of the filter cartridge 24. These openings 31 may be louvers or mesh openings such as the openings 31 in internal tube 26 and external tube 28 of the filter cartridge 24, as described above. A complete solid stopper plate 30 prevents exhaust gas from escaping through the end of the filter cartridge 24, thereby forcing the exhaust gas to pass and exit through the internal tube 26, the diatomite pellets 40 and the

external tube 28 of the filter cartridge 24, respectively. A stopper plate 30 having openings 31, as described above, may allow exhaust gas to pass and exit through the external tube 28 and/or the openings in the stopper plate 30 after passing through the diatomite pellets 40.

[00040] In another embodiment of the present invention, the filter cartridge 24 may also comprise an additional mesh tube 60 operatively located outside and around external tube 28, as shown in FIGURE 6. This additional mesh tube 60 provides an additional means of filtering the exhaust gas from an engine. Mesh tube 60 also slows and controls the treated exhaust gas exiting the external tube 28. Specifically, mesh tube 60 slows and controls the exiting exhaust gas so that it remains in the diatomite pellets 40 for a longer time than if the mesh tube 60 was not around the external tube 28. This allows for additional absorption of odors, fumes, liquids and undesired gases from the exhaust gas so that the exiting gas is essentially free of these odors, fumes, liquids and undesired gases which can pollute the environment. The mesh tube 60 is preferably made from the same mesh material as described above in the embodiment where the tubes 26, 28 may be made from a mesh material.

[00041] The additional mesh tube 60 may also have a mesh end cap 62 which aids in and serves the function of the mesh tube 60. The mesh end cap 62 is preferably in a substantially planar arrangement with the stopper plate 30 or adjacent to the stopper plate 30. However, any suitable arrangement may be used.

[00042] In the preferred embodiment, the additional mesh tube 60 is used in conjunction with internal tube 26 and external tube 28 also being a mesh material, as described above. However, the additional mesh tube 60 may be used in conjunction with internal tube 26 and external tube 28 being louvered, as described above, or any other suitable embodiment.

[00043] The filter cartridge 24 may be operatively positioned inside of the guard casing 12 such that a gas passage 32 is formed in-between an internal surface of the guard casing 12 and the external surface of external tube 28 of the filter cartridge 24.

[00044] The internal surface of the guard casing 12 may be an alloy layer 20. However, an alloy layer 20 may be a separate layer operatively positioned inside of the guard casing 12. The alloy layer 20 may be a metal or aluminum alloy material or any other suitable material. The alloy

layer 20 is provided in a thickness in a range of 16 gauge to 18 gauge. Where the alloy layer 20 is a separate layer, gas flow passages 22 may preferably be formed in-between the internal surface of the guard casing 12 and the alloy layer 20, as shown in FIGURE 2. These gas flow passages 22 provide an additional means for treated exhaust gas to exit the filtering system 10.

[00045] The internal surface of the guard casing 12 of the filtering system 10 may also have a protective coating. The protective coating may be a spray or a mat capable of withstanding the high temperatures associated with internal combustion engine exhaust emission. A preferred mat is the Interam® Brand Mat Mount manufactured by 3M, St. Paul, Minnesota (U.S. Patent No. 3,916,057). The Interam® Brand Mat Mount combines the high temperature capabilities of ceramic fibers with the high thermal expansion characteristics of vermiculite. The mat can withstand high temperatures, seal against exhaust gas bypass, reduce the skin, i.e. external, temperature of the filtering system, and resist thermal shock and vibration.

[00046] In an embodiment having an alloy layer 20, the gas passage 32 is formed between the alloy layer 20 and the external surface of the external tube 28. However, in an

embodiment having an additional mesh tube 60, the gas passage 32 is formed between the alloy layer 20 or guard casing 12 and the external surface of the additional mesh tube 60.

[00047] The filter cartridge 24 may be secured to the gas inlet end structure 14 of the guard casing 12 by any suitable means such as, but not limited to, screw threaded flanges, welding or glue.

[00048] Within the filtering system 10, at least one spacing member, i.e., bracket 18 or holder plate 18', may preferably be coextensive with an internal surface of the guard casing 12 and an external surface of the filter cartridge 24. The spacing member, i.e., bracket 18 or holder plate 18', preferably holds the filter cartridge 24 in place inside the guard casing 12 of the filtering system 10 of the present invention. The at least one spacing member is preferably a bracket 18 or a holder plate 18', but it can be any suitable spacing member. The at least one spacing member can be formed from stainless steel, aluminum-coated steel, lead-coated steel, aluminum, polymer-fiberglass, or any combination thereof. However, any suitable material may be used to form the at least one spacing member, i.e., bracket 18 or holder plate 18'.

[00049] The guard casing 12, gas inlet end structure 14 and gas outlet end structure 16 may be any suitable structure and formed from any suitable material. However, in a preferred embodiment of the present invention, the guard casing 12, the gas inlet end structure 14 and the gas outlet end structure 16 are preferably formed from stainless steel, aluminum-coated steel, lead-coated steel, aluminum, a polymer-fiberglass material or any combination thereof. The polymer-fiberglass material is preferred to form the guard casing 12 and/or end structures 14 and 16 of the filtering system 10 since this material is lightweight, strong and heat resistant. Specifically, the polymer-fiberglass material can withstand temperatures up to 1300°F and as such, can withstand typical heat exhaust which is usually in the temperature range of from about 150-200°F.

[00050] The gas inlet end structure 14 may be any suitable structure. A preferred embodiment of a gas inlet end structure 14 is shown in FIGURES 2, 6 and 8. This gas inlet end structure 14 preferably has a male mating end 64 which may or may not be threaded. The male mating end 64 is adapted for fitting the end of an exhaust tailpipe. The male mating end 64 may be secured to the exhaust tailpipe 72 of an internal combustion engine by any suitable means

including, but not limited to, by a threaded reception, glue or welding. For example, FIGURE 8 illustrates various securing means in conjunction with each other. Specifically, the gas inlet end structure 14 has a threaded connection 13, which is then secured to an optional pipe 90 by a glue connection 15, which is then secured to a tailpipe 72 by a suitable securing means.

[00051] This type of gas inlet structure 14 allows the exhaust gas to flow from the engine into the filtering system 10 through the gas inlet end structure 14 and into the core air passage 34. The exhaust gas is prevented from directly entering any other part of the filtering system 10 before entering the core gas passage 34 by an annular closure 66. Additionally, the annular closure 66 closes to the atmosphere the gas entry end, including the end of the gas passage 32, of the filtering system 10. The exhaust gas entering the gas inlet end structure 14 flows along a path from the core gas passage 34 outwardly through the internal tube 26, through the diatomite pellets 40 and then through the external tube 28 of the filter cartridge 24, as shown by the arrows in FIGURES 2 and 6. The diatomite pellets 40 absorb the undesired gases and fumes from the exhaust gas such that the exhaust gas is free from these gases and fumes

when it exits the external tube 28 into the gas passage 32 inside of the guard casing 12. The gas then flows into the environment through the gas outlet end structure 16.

[00052] In an embodiment having an additional mesh tube 60, the exhaust gas exiting the external tube 28 must also pass through the mesh tube 60 before entering the gas passage 32. Specifically, the exhaust gas flows along a path from the engine into the core gas passage 34 outwardly through the internal tube 26, through the diatomite pellets 40, through the external tube 28 and then through the mesh tube 60 into gas passage 32, as shown by the arrows in FIGURE 6.

[00053] In the embodiment shown in FIGURE 5, the gas inlet structure 14 can be in the form of a cap having screw threaded flanges 70 mating with screw threads formed in the end of the guard casing 12. This embodiment of a gas inlet end structure 14 preferably includes a means for connecting the filtering system 10 to a tailpipe 72', shown in dashed lines, of an internal combustion engine by means of a conventional, reduced diameter neck 74 and the usual circumferential slots 76 and coacting tightening band 78. This embodiment of a gas inlet end structure 14 may also include an annular closure diaphragm 80 which closes to the

atmosphere the gas entry end of the filtering device 10 and closes the ends of gas passage 32. An opening in this diaphragm 80 coincides with the reduced neck 74 to allow entry of the engine exhaust gases to be treated.

[00054] A spacing element 82 carried by the gas inlet end structure 14 acts as a stop for the filter cartridge 24 in spaced relation to the gas inlet end structure 14, thereby forming a gas distributing plenum 83 which, as shown by the arrows in FIGURE 5, distributes the entry exhaust gas over the end of the filter cartridge 24 and into the entry ends of gas passage 32 which may be observed open into the plenum 83. The exhaust gas then flows along a path from the gas passage 32 inwardly through the external tube 28, through the diatomite pellets 40 and then through the internal tube 26 of the filter cartridge 24 into the core gas passage 34, as shown by the arrows in FIGURE 5. The diatomite pellets 40 absorb the undesired gases, fumes and the like from the exhaust gas such that the exhaust gas is free from these undesired gases, fumes and the like when the gas exits the internal tube 26 into the core gas passage 34 of the filter cartridge 24. The gas then flows into the environment through the gas outlet end structure 16.

[00055] A disc 84 may optionally be operatively located in the embodiment of the gas inlet end structure 14 shown in FIGURE 5 such that it acts to prevent the entering exhaust gases from flowing straight through the core gas passage 34 of the filter cartridge 24 of the filtering system 10 without passing through the diatomite pellets 40.

[00056] The gas outlet end structure 16 may be any suitable structure. A preferred embodiment of a gas outlet end structure 16 is shown in FIGURES 2, 6 and 8. This gas outlet end structure 16 may be an opening in the exiting end of the guard casing 12. This gas outlet end structure 16 may also be an elongated outwardly projecting neck or channel structure opening at the exiting end of the guard casing 12. As shown in FIGURES 2, 6 and 8, this type of gas outlet end structure 16 allows the filtered exhaust gas to flow from the gas passage 32 into the environment. This type of gas outlet end structure 16 is preferably used in conjunction with a filter cartridge 24 that does not extend the entire length of the guard casing 12 and with a filter cartridge 24 which has a stopper plate 30, as described above.

[00057] As shown in FIGURE 5, another preferred embodiment of the gas outlet end structure 16 can also be in

the form of a cap with threaded flanges 46 coacting with threads in the exiting end of the guard casing 12. An annular diaphragm 48 closes this end of the guard casing 12 to the atmosphere with an opening 50 for discharging the exhaust gas which has been treated. In this preferred embodiment, the opening 50 may preferably include a screen 52 for preventing the loss of pulverulent material from the filter cartridge 24 of the filtering system 10. A threaded neck 54 may extend inwardly from the gas outlet end structure 16 and may have a flange which is secured to the diaphragm 48. This gas outlet end structure 16 of the filter cartridge 24 may also be closed by a diaphragm 56 carrying an inwardly projecting neck 58 in which are formed female screw threads which mate with those on neck 54.

[00058] As shown in FIGURE 5, this type of gas outlet end structure 16 allows the filtered exhaust gas to flow from the core gas passage 34 into the environment. This type of gas outlet end structure 16 is preferably used in conjunction with a filter cartridge 24 that extends the entire length of guard casing 12. Additionally, it will be seen that when the efficiency of the filtering action of the filter cartridge 24 is reduced due to clogging and/or poisoning of the carbon, by unscrewing this gas outlet end

structure 16, the used filter cartridge 24 can be withdrawn and a fresh filter cartridge 24 inserted into the filtering system 10.

[00059] While preferred embodiments are described above, any suitable guard casing 12, gas inlet end structure 14 and gas outlet end structure 16 may be used in conjunction with the filter cartridge 24 of the present invention.

[00060] The novel form of the filter cartridge 24 which coacts with the filtering system 10 of the present invention is one in which the adsorbent diatomite pellets 40 are arranged in such a way inside the tubes 26 and 28 of the filter cartridge 24 that the filter cartridge 24 is gas permeable longitudinally from the gas entry end, or from the plenum 83 if used in the embodiment, radially through the concentric tubes.

[00061] In another preferred embodiment, the gas inlet end structure 14 between disc 84 and the external surface of the filtering device may be closed by a porous annular sheet of fiberglass paper which permits free flow of gases into the end of the filter cartridge 24 but restrains the pulverulent adsorbent material from escaping. If desired, a layer of perforated foil (not shown) can form the outer cylindrical surface of the filter cartridge 24, where a skin

of this nature might be advisable to protect the filter cartridge 24 during shipping and handling and prior to insertion into the filtering system 10.

[00062] FIGURE 7 shows an exemplary positioning of the filtering system 10 of the present invention to a tailpipe downstream of a conventional internal combustion engine (not shown). Any suitable securing means may be used to secure the filtering system 10 to a tailpipe, including but not limited to threaded connection, glue or welding.

[00063] The filter cartridge 24 can be made and sold separately for inclusion in filter systems, e.g. mufflers structured to receive the filter cartridge 24. When the life of the filter cartridge 24 is spent, the filter cartridge 24 is removed and can be reconditioned for reuse or disposed of and replaced with a new filter cartridge 24.

[00064] The exemplary embodiments herein disclosed are not intended to be exhaustive or to unnecessarily limit the scope of the invention. The exemplary embodiments were chosen and described in order to explain the principles of the present invention so that others skilled in the art may practice the invention. As will be apparent to one skilled in the art, various modifications can be made within the scope of the aforesaid description. Such modifications

being within the ability of one skilled in the art form a part of the present invention and are embraced by the appended claims.